# Potential Risks to Infants from Breastfeeding

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# Overview

- **Potential Risks from Consumption of breast milk**
  - DEQ risk assessment approach
- **Benefits from breastfeeding**
  - DHS perspective

# Introduction

- **Portland Harbor Federal Superfund Site**
- **Various exposure pathways, including fish consumption**
- **Breastfeeding suggested as a potential exposure pathway years ago**

# Risk Calculations

- **Equations taken from EPA RA guidance for combustion facilities (Sept 2005)**

- **Previously applied at Housanic River site**

- **Reasonable assumptions, particularly given consumption of PBTs in fish**

- **Use PCBs as example**

# Conceptual Model

**PCBs in fish** → Dose → **Body burden in mother** → Dose → **Breast-feeding infant**
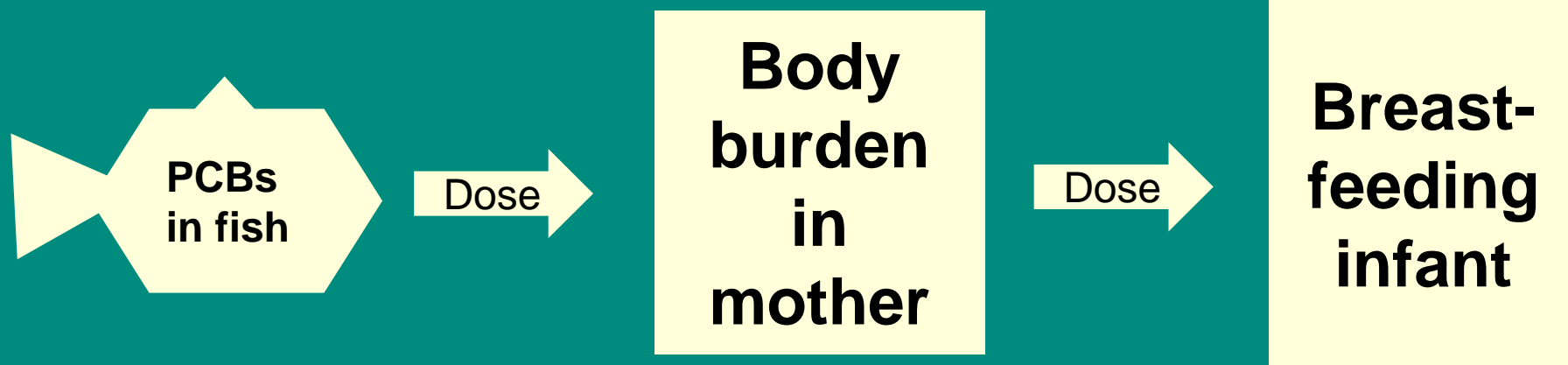
# Dose to Mother

$$ADD_{mother} = \frac{C_{fish} \times IR_{fish} \times CF \times F_{fish}}{BW_{af}}$$

**Where:**

| | | |
|---|---|---|
| $ADD_{mother}$ | = | Average daily dose to mother (mg/kg/day) |
| $C_{fish}$ | = | Chemical conc in fish (assume 1 mg/kg) |
| $IR_{fish}$ | = | Ingest rate of fish (subsist rate of 142.4 g/day) |
| CF | = | Conversion factor (0.001 kg/g) |
| $F_{fish}$ | = | Fraction of fish contaminated (1) |
| $BW_{af}$ | = | Body weight (66 kg for average adult female) |

# Dose to Mother

$$ADD_{mother} =$$

$$= 1 \text{ mg/kg} \times 142.4 \text{ g/day} \times 0.001 \text{ kg/g} \times 1 / 66 \text{ kg}$$

$$= 0.0022 \text{ mg/kg/day}$$

# Concentration in Milkfat

$$C_{milkfat} = \frac{ADD_{mother} \times h \times f1}{ln(2) \times f2}$$

**Where:**

$C_{milkfat}$ = PCB concentration in milkfat (mg/kg-lipid)

$ADD_{mother}$ = Average daily dose to mother (mg/kg/day)

h = Half-life of PCB (7 years = 2555 days)

f1 = Fraction of ingested PCB stored in fat (0.9)

f2 = Fraction of mother's weight that is fat
(0.3 kg-lipidBW/kg-totalBW)

# Concentration in Milkfat

$$C_{milkfat} =$$

$$= \frac{0.0022 \text{ mg/kg-totalBW/day} \times 2555 \text{ days} \times 0.9}{0.693 \times 0.3 \text{ (kg-lipidBW/kg-totalBW)}}$$

$$= 24 \text{ mg/kg-lipid}$$

# Dose to Infant

$$ADD_{nc\text{-}child} = \frac{C_{milkfat} \times IR_{milk} \times f3 \times f4 \times EDc \times EFc}{ATnc \times BWc}$$

**Where:**

$ADD_{nc\text{-}child}$ = Average daily dose for breastfeeding child (mg/kg/day)

$C_{milkfat}$ = Concentration of chemical in milk fat (mg/kg-lipid)

$IR_{milk}$ = Ingestion rate of breast milk (0.69 kg-milk/day)

f3 = Fraction of breast milk that is fat (0.04 kg-lipid/kg-milk)

f4 = Fraction of ingested PCB that is absorbed (0.9)

EDc = Exposure duration of breastfeeding child (1 year)

EFc = Exposure freq of breastfeeding child (365 days/year)

ATnc = Averaging time – non-carcinogen (= EDc x EFc)

BWc = Body weight of breastfeeding child (9.4 kg)

# Dose to Infant

$$ADD_{nc\text{-}child} =$$

$$= \frac{24 \text{ mg/kg-lipid} \times 0.69 \text{ kg-milk/day} \times 0.04 \text{ kg-lipid/kg-milk} \times 0.9 \times 1 \text{ yr} \times 365 \text{ day/yr}}{1 \text{ yr} \times 365 \text{ day/yr} \times 9.4 \text{ kg}}$$

$$= 0.063 \text{ mg/kg/day}$$

# Calculated Noncancer Risk

$$HQ_{child} = \frac{ADD_{child}}{RfD}$$

**Where:**

$HQ_{child}$  =  **Hazard quotient for breastfeeding child**

RfD      =  **Non-cancer reference dose ($2 \times 10^{-5}$ mg/kg/day for total PCBs)**

$HQ_{child}$ =  **0.063 mg/kg/day / 0.00002 mg/kg/day  =  3,200**

# Calculated Cancer Risk

$$ELCR_{child} = ADD_{child} \times SFo$$

**Where:**

$ELCR_{child}$ = Excess lifetime cancer risk to child from breastfeeding

$SFo$ = Oral cancer slope factor $2 \; (mg/kg/day)^{-1}$ for total PCBs

$ELCR_{child}$ = $0.00091 \; mg/kg/day \times 2 \; (mg/kg/day)^{-1}$
$= 2 \times 10^{-3}$

# Uncertainty

- **Monkey LOAEL used for RfD**
  0.005 mg/kg/day / 300 UF =
  = 0.00002 mg/kg/day
- **Confounding effects of prenatal exposure**
- **One year exposure (not lifetime)**
- **Body burden reduction**
  480 mg / 2 = 240 mg
- **Risk contribution from other chemicals (DDT, dioxins, etc.)**

# DEQ Conclusions

- **We have risk assessment tools to evaluate risks by breast feeding route**

- **There are potentially significant risks to breast feeding infants of high fish consumption mothers**

- ***But*, DHS tells us that breast feeding is good for you**

# DHS Perspective

- **What is the message for public health?**

    - No threshold value for contaminants in milk
    - How do we balance uncertain health risks with certain health benefits?
    - Our numbers in the context of other studies
    - Who do we target with the message we develop?
    - What public health actions are appropriate?

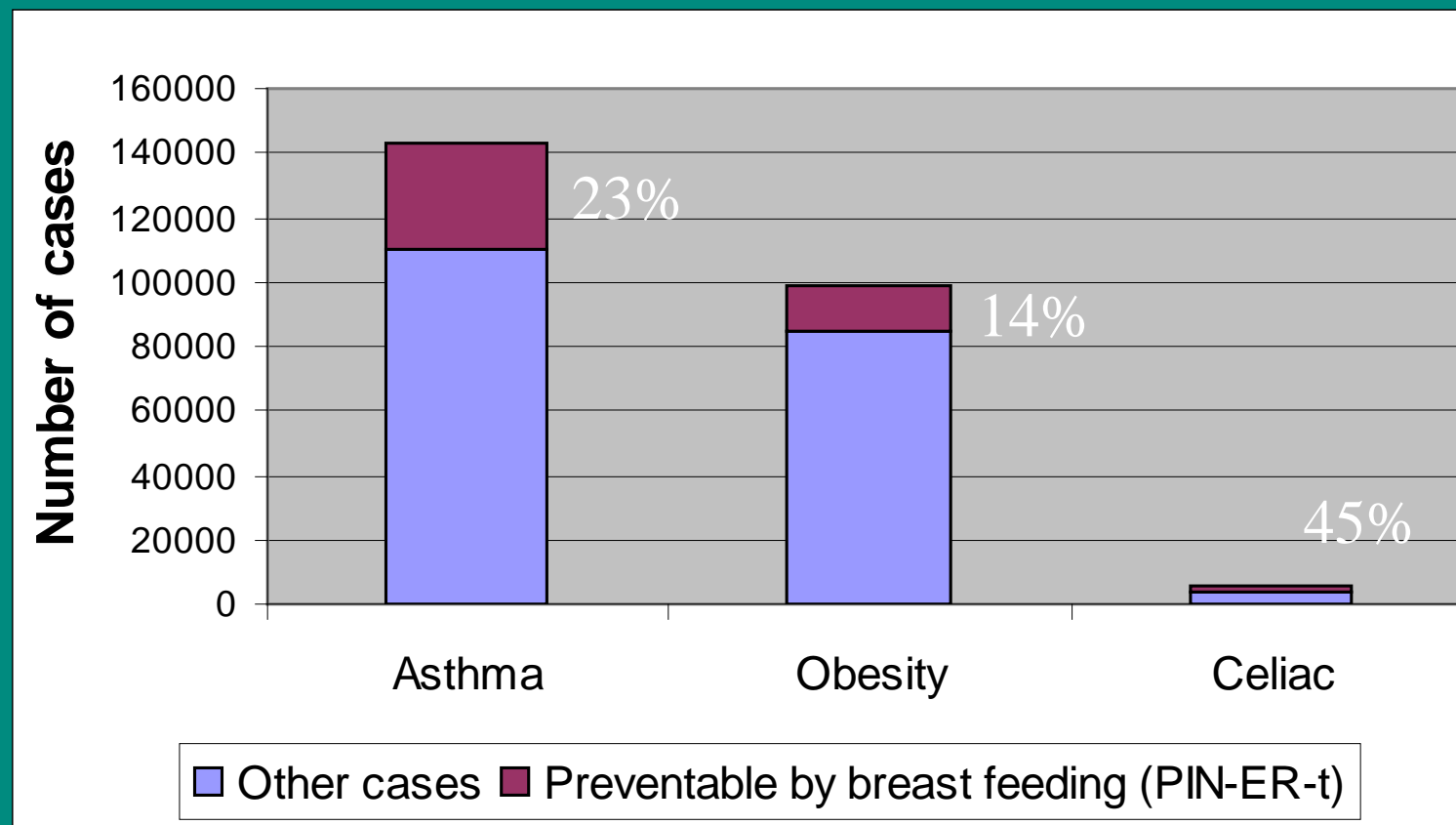# No Accepted Threshold Value for Contaminants in Breast Milk

To Breastfeed

Not to Breastfeed

= ?
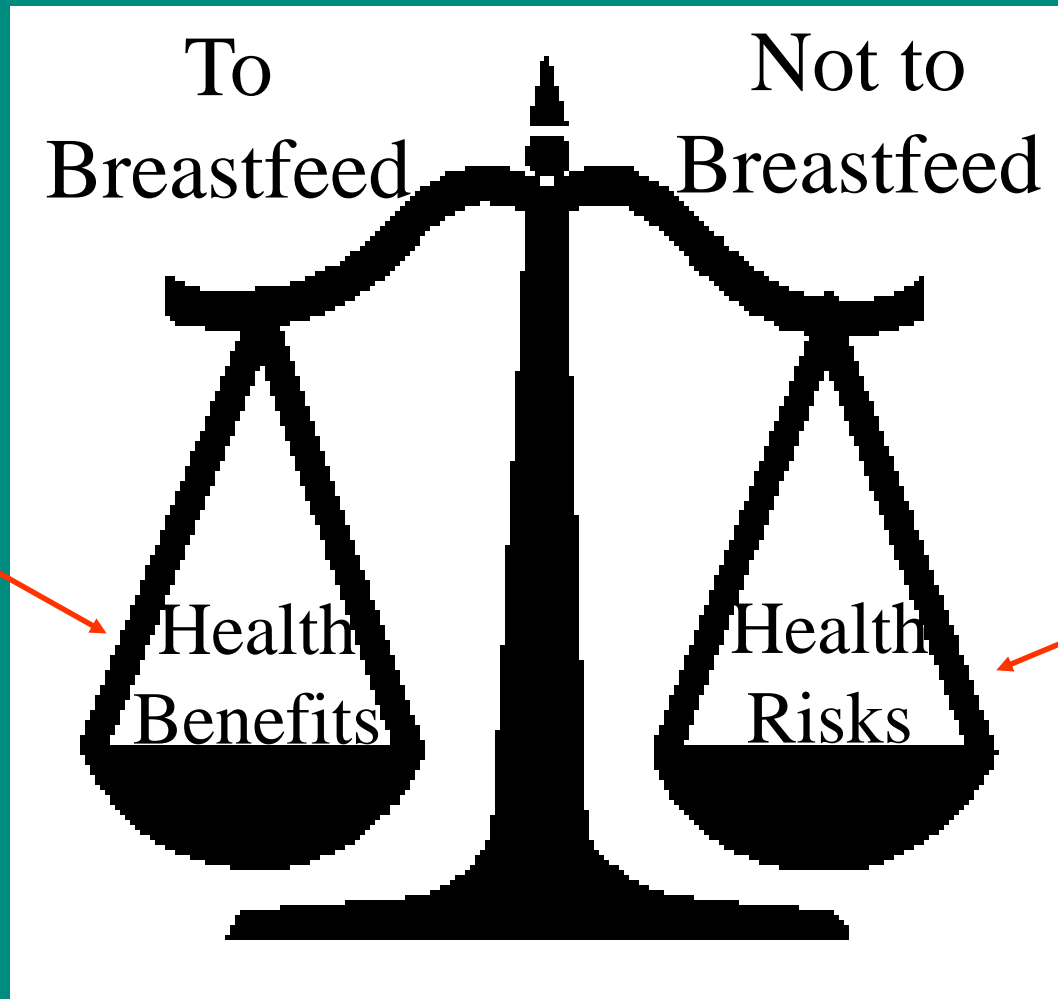
Very limited quantification methods

Well established quantification methods

Health Benefits

Health Risks

# New Method to Quantify Benefits



Adapted from Akobeng et al. 2007

PIN-ER-t = Population Impact Number of Eliminating a Risk Factor Over a Time Period

# Risks Must be Weighed Against Benefits

- **Breastfeeding is healthy**
  - Boosts immune function
  - Reduces risk of several chronic health conditions
  - Improved IQ and neurocognitive function
  - Perfectly balanced and inexpensive nutrition
  - Non-breastfed infants have a 21% higher mortality rate

- **PCBs are not healthy**
  - Impair immune function
  - Impair neurocognitive function
  - Probably carcinogenic

# Risks Must be Weighed Against Benefits

- **Breastfeeding is also healthy for the mother**
  - Enhanced psychological well-being (mother and child) and increased bonding between mother and child
  - Reduced postpartum bleeding
  - Reduced risk of breast and ovarian cancer
  - Easier loss of excess adipose accumulated during pregnancy

# Calculated PCB Dose in Context of Background and Health Effects

- **Calculated 24 mg/kg-lipid for PH**
- **Measured background world-wide 0.16 – 4 mg/kg-lipid with some as high as 15 mg/kg-lipid**

# Calculated Dose in Context of Background and Health Effects

- **At highest breast milk levels, subtle health effects observed:**
  - Deficit in composite activity rating
  - Deficits in standardized neurocognitive tests
- **In most cases, children with deficits caught up with peers in early childhood**
- **In all cases where comparison was made, breastfed children (even with increased PCBs) still did better than formula-fed children.**

# Message from Medical Profession and Health Agencies

- **WHO and American Pediatric Association both say that breast feeding is always the best option regardless of contaminant levels.**

- **No one has ever measured PCB levels in breast milk as high as those we've calculated.**

# Current Message from Oregon Public Health

# Current Fish Advisory for Portland Harbor

- **Women of childbearing age, particularly pregnant or breastfeeding women, children and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor, especially carp, bass and catfish.**

# Who Would we Target with Message?

- **Populations that continue to eat fish at subsistence levels are small and closed – mainly Eastern European communities.**

# What is the Appropriate Public Health Action to Take?

- **Considerable effort already made**
- **Given the small, closed nature of affected population, no further action beyond existing fish advisories is feasible.**
- **Propose outreach and education as part of the remedy to PRPs funding clean-up?**

# Conclusions and Questions

- **We have risk assessment tools to evaluate risks by breastfeeding route**
- **We have less tools to quantify the health benefits of breastfeeding**
- **There are potentially significant risks to breastfeeding infants of high fish consumption mothers**
- **Existing literature overwhelmingly suggests that the health benefits of breastfeeding outweigh potential risks**
- **Do we present the results of the risk assessment?**
- **How do we present the results?**